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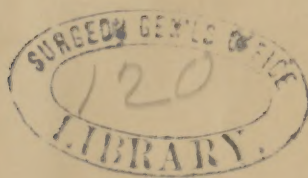
A Hansen.

Reprint from the Therapeutic Gazette, 1886.

ON QUEBRACHO BARK.

(ASPIDOSPERMA QUEBRACHO.)

TRANSLATED FROM THE GERMAN.



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BOTANIC-PHARMACOGNOSTIC ESSAY BY

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(Illustrated by three Plates containing twenty-five Lithographic Figures.)

Reprint from the Therapeutic Gazette, 1880.

PREFACE.

Soon after the introduction of quebracho bark, this remedy attracted considerable attention. The limited knowledge we possessed of the drug itself, and the difficulty of obtaining it, as well as the occurrence of frequent substitutions of false varieties for the true drug, caused considerable confusion, which was not in the least diminished by numerous communications of results obtained from all kinds of barks. A large number of short notices of the bark and its therapeutic effects appeared in the medical and pharmaceutical journals without, however, a report of any thorough examination of the bark itself. The only serviceable reference was contained in a description by Dingler, appearing with Fraude's chemical publication. As I was in possession of material of undoubted genuineness, it appeared to be of sufficient interest to furnish an elaborate description of the bark, above all in a pharmacognostic sense, thus enabling us to identify it and render further substitutions impossible.

An examination of the wood was undertaken at the same time with that of the bark.

The work, which was begun in the interest of therapeutics, brought ample reward in the discovery of several anatomical peculiarities.

All the illustrations are drawn from nature; the accompanying number designates the microscopic enlargement.

ERLANGEN, May, 1880

SOURCE OF THE BARK.

In the beginning of the year 1878, Herr F. Schickedanz sent a collection of vegetable drugs from the Argentine Republic to Erlangen for examination and valuation. Among these samples was a bark which has since then attracted considerable attention; a member of the Apocynæ, *Aspidosperma Quebracho*, Schlechtendal.

Attention was attracted to this bark principally by the comments of Schickedanz; he wrote:

"*Aspidosperma Quebracho* is a tree occurring quite commonly in the province of Santiago, and in the bosom of the valley in which the city of Catamarca is situated. I know of only one group of these trees, on this side of the Ambato, standing near the outlet of the Quebrada-del-Molle, about four leguas east of Pilciao, whence the bark is obtained. The tree belongs to the order Apocynæ and was named by Schlechtendal *Aspidosperma Quebracho*; the bark has been in use for many years as a febrifuge, and, according to the views of the physicians of Tucuman, is equal to the cinchona barks in activity." The great importance of the cinchona barks and their alkaloids as curative agents made it a matter of the first importance to determine the correctness of the views which ascribed to *Quebracho* an equal rank and value.

During the period in which the chemical examination was progressing under the direction of G. Fraude* at the Munich laboratory, other experiments to determine its therapeutic action were instituted by Dr. F. Penzoldt. The former resulted in the discovery of an alkaloid which seems, at least theoretically, related to the cinchona alkaloids, while the latter researches brought about a knowledge of the wonderful efficacy of the remedy in dyspnœa, though the praise awarded to it for its antifebrile properties was not found justified.

* G. Fraude, *Berichte d. deutsch. chem. Gesellsch.* 1878, p. 2189, 1869 p. 1558 u. 1560.

This unexpected action of Quebracho bark at once elevated it to the rank of valuable remedies, though the suddenness of the discovery was attended by a dearth of further material, the original shipment containing only limited quantities. The natural consequence was an eager attempt to obtain parcels of the drug, which was difficult enough, inasmuch as jobbers and druggists possessed no acquaintance with the article sufficient for its identification, † and besides it must necessarily be obtained from a foreign source.

The limited knowledge available regarding its botanical source gave rise to much confusion and variation in the parcels brought into the market, which again threw doubts on the correctness of the pharmacological discovery. This state of uncertainty was greatly aided by the fact that in its native country, species of entirely different families received the popular designation of "Quebracho."

The word itself composed of "quebrar" and "hacha" signifies "breaking the axe," and trees with very hard wood commonly received this designation without regard to their application in a scientific way, a circumstance frequently occurring in our own country. It is, therefore, an imperative necessity to establish the identity of the sample obtained from the first sender, which will be greatly assisted by a study of the history of this plant, which possesses, in fact, an ample though somewhat scattered literature. Through the extended travels and thorough researches of Martius, ‡ in which he was aided by a complete equipment of apparatus and material, and which have, not unjustly, caused him to be named the second discoverer of Brazil, we have been placed in possession of an extended knowledge of the vegetation of that country. An imposing evidence of this fact is found in the "Flora Brasiliensis" begun by Martius and numerous other botanists, and continued by Eichler. The great neighboring territory of the pampas has been as yet but slightly explored, botanically. By pampas we usually understand the treeless plains of South America, overgrown with giant grasses, such as stretch in unmeasured grandeur from the La Plata to the Rio Colorado. In a botanico-geographical sense, however, the term "pampas" includes the entire area of country between the southern boundary of Brazil to near the southern terminal point of South America; it embraces, therefore, the La Plata states and Patagonia.

Of late years the Argentine Republic has endeavored to aid in the development of this section by the appointment of German naturalists for the purpose of exploration, so that we may indulge the hope that this rich country may be opened up to the civilized world. An evidence of these labors is found in the publications of Burmeister and Grisebach. Several descriptions of the different plants indigenous to the Pampas can be found in a history by A. Jacques,* of a military expedi-

tion undertaken against the predatory bands of Indians who had ravaged the extreme southern settlements of the Argentine Republic. Among the plants mentioned, of which short characteristic descriptions are given, we find also the following:

"Quebracho, two varieties, the white and red, differing from each other not only in the color of their wood, but also in the structural peculiarities of the flower and fruit. The small, glistening, pointed, myrtle-like leaf is not deciduous in winter, the green color merely deepens, and new leaves of a more delicate shade sprout from the ends of the twigs; the intense solar heat, however, causes them to fall in summer. Its wood is of extraordinarily close texture and hardness, so that it may be used to replace the iron of wagon axles and the rollers used for crushing sugar-cane."

The extended travels of Burmeister † through the La Plata States were, then, the means of giving the first important information as to their botanical and general conditions. While on this journey, Burmeister met with Quebracho, and through him the first specimens of the fruit and twigs of this tree were sent to Europe. It will, perhaps, be of interest to quote from Burmeister's own words a description of the discovery of this tree, which I take from his report. At this time he was on the road between Cordova and Tucuman:

"July 19th. Our departure from Chafnar took place at night. As the sun rises we are already at the first station beyond, Pozo-del-Tigre, a distance of four leguas. Our surroundings were low woods with groups of palms, as heretofore, without anything characteristic. Two leguas beyond Pozo the palms ended, and were replaced by low bushes of an unfamiliar species of Syngenesia, with fine reversed heart-shaped leaves, such as were found at Mendoza. In this manner we arrived at Portezuelo, five leguas from Pozo, lying between high, rounded, bare, granitic hills on the banks of a clear brook. The appearance of this spot made a most peculiar and horrible impression on me, so wild and weird was its character; we found, however, a friendly family who shared with us their breakfast, which was then waiting. At this point we had entered the Province of Santiago-del-Estero, reported to be 620 metres above the level of the sea; it is four leguas from here to Orquetas, the next station. The landscape still produces a very melancholy impression; it is covered with low shrubbery between the constantly occurring naked granite rocks. Farther on we met with a few large species of Cactus; Opuntias of giant form and tall trunks; still further on the landscape becomes more picturesque by the appearance of a tree characteristic of this region as far as Tucuman, viz.: Quebracho. This tree presents the appearance of an erect high trunk carrying a spreading crown whose drooping extremity bears finely pointed twigs. As I was unable to determine the plant botanically, at this time, I collected several of the rather numerous oval fruits, an examination of which has since resulted in the discovery that the

† F. Penzoldt, Berl. klin. Wochenschr. 1879 N. 19.

‡ Martius and Spix. Journey to Brazil. Munich, 1824-31. Vol. 3.

* Excursion au Rio-Salado et dans le Chaco, Confédération Argentine. Par Amédée Jacques (Extrait de la Revue de Paris du 1 et 15 Mars 1857) Paris 1857.

† H. Burmeister. Travels through several northern provinces of the La Plata States. Zeitschrift f. allgemeine Erdkunde N. F., 1860. Bd. IX.

specimens belong to the order Apocynæ, genus, *Aspidosperma*, Mart., and is, without doubt, a still undescribed variety. This tree is of great commercial importance to the country on account of the value of its wood, which is used for building purposes, particularly the variety known as "Quebracho colorado," whose wood, of extreme hardness, is of a blood-red color, which in course of time becomes quite black, while the other variety known as "Quebracho blanco," remains white. The leaves of the former are small, fine, simple lanceolate, while those of the latter are broader and ovate-lanceolate. In this beautiful forest of Quebracho I was taken so sick that to my regret I was unable to pay further attention to my surroundings. I merely know that the region as far as the Rio Dulce was of the same character, on both sides of which a low meadowy vegetation extended, intermixed with *Salicornias*, the soil strongly impregnated with salt, and further on a repetition of the Quebracho forest, now interspersed with numerous individuals of a species of *Cereus* of high candelabra-like forms, which emerged from the bushy undergrowth and reached to the crowns of the Quebracho trees. Both were, however, distributed at intervals, and did not form an unbroken forest."

Thus far Burmeister's account of Quebracho. Being himself unable to determine the plant, he sent a number of twigs and fruits to Schlechtendal. The fruits bore an undoubted resemblance to those classified by Martius and Zuccarini as *Aspidosperma*. They were identical with the fruits illustrated as belonging to the genus *Aspidosperma* in Martius' Nov. gen. et spec., plate 1, 34, and 36, and in the Flora Braziliensis fascic. 26, plate 13 and 15, and show only a slight diversity of form and flexion. The fruit will also be found illustrated in the Botanische Zeit., 1861, plate 5. Although no sample of Quebracho colorado was obtained from Burmeister, nevertheless, Schlechtendal concluded that both plants must belong to the same species, having the same vulgar name, and consequently classified them as belonging to the genus *Aspidosperma*. He named the one *Aspidosperma* Quebracho blanco, and the other *Aspidosperma* Quebracho colorado. This error referred to by Grisebach,* gave rise to much confusion, until removed by the receipt of further material for examination.

Succeeding Burmeister's researches was the

* A. Grisebach Vegetation of the Earth. vol. 2, page 620. 1872. "We distinguish two varieties of Quebracho, blanco and colorado. Schlechtendal examined the fruits of Quebracho blanco and referred them to the genus *Aspidosperma* of the tropical Apocynæ. According to his illustration the fruits are identical; as the flower, however, is unknown and the leaves occur in whorls or are opposite in this specimen, and in the determined varieties are alternate, the classification still requires further substantiation. A decided error, however, was committed by him in classifying Quebracho colorado as belonging to this species, seemingly without being in possession of specimens and regardless of the fact that these have not the flat two lobed capsules of *Aspidosperma* according to the description of Tweedie, (Ann. Nat. Hist. 4, p. 101), but bore large clusters of red fruits similar to those of the sycamore, (*Ficus*). The fact that the designation, "quebracho," really "quebrar hacho" (breaking the axe) refers to the hardness of the wood and not to any special family of trees, seems to be confirmed by Orbigny's report on Corrientes, who includes therein also a species of *Acacia*."

important journey of Lorentz, in the northwestern part of the La Plata States, which had been the least explored. This journey, which was undertaken at the instance of the Argentine Republic, materially aided botanical science in that country; it occurred during the years 1871-72, and included the provinces of Cordoba, Santiago del Estero, Tucuman and Catamarca, lying between 26° and 31° south latitude. Inasmuch as Lorentz was not in possession of the necessary scientific appliances, he transmitted the material collected to Grisebach, and the latter published the results of his investigations in a large treatise entitled "Plantæ Lorentzianæ,"† Among this collection were a sufficient number of specimens for examination of both plants, Quebracho blanco and Quebracho colorado, so that it was possible for Grisebach to determine and correct the error previously made by Schlechtendal with reference to the latter species. It was discovered that the plant known in the Argentine Republic as Quebracho colorado belongs to quite a different family than Quebracho blanco. The first named tree does not belong to the genus *Aspidosperma* nor even to the Apocynæ, but is a member of the Terebinthaceæ, and is to be classified under the genus *Anacardium*. Inasmuch as Schlechtendal's classification had thus been proven incorrect, it was named by Grisebach "Loxopterygium, Gr." It is described on page 115 of the "Plantæ Lorentzianæ"; Schlechtendal's classification of the Quebracho blanco was, however, found correct, and it therefore retained that name.

In a second treatise of Grisebach's,* on Argentinian plants, occurred other descriptive notices, which removed all possible sources of error. On page 224 it is stated, according to a communication of Hieronymus, that *Aspidosperma* Quebracho obtains in the entire country the title of "Quebracho blanco," and not "Quebracho colorado." Further, it is mentioned in the same treatise, p. 95, as an appendix to a repeated diagnosis of *Loxopterygium*, that also, in accordance with the statement of Hieronymus, the popular name of "Quebracho colorado," is used in both the provinces of Tucuman and Santiago del Estero to designate only *Loxopterygium*.

In entire accordance with the foregoing are the statements most recently made by Hieronymus in Cordoba, who is the best authority on this subject. These latter were communicated by Herr Primke in No. 9 of the Pharm. Zeit., 1880, which I quote verbatim:

"As Quebracho, are designated the following trees belong to different families of plants, and their parts which are of commercial value as raw material:

1. *Aspidosperma* Quebracho Schlechtendal, Apocynæ, local name, Quebracho blanco. This tree grows in the Province of Catamarca, of the Argentine Republic; the bark is used by the natives as a remedy for malaria and asthma.

† Plantæ Lorentzianæ. Description of the first and second collections of Prof. Lorentz at Cordoba. Publ. by the Imp. Society of Sciences at Göttingen. 1874. p. 49.

* Symbolæ ad Floram Argentiniam. Second descriptive treatise on Argentinian Plants. Publ. by the Imp. Society of Science at Göttingen. 1879. Vol. 24.

2. *Loxopterygium*, (*Quebrachia*) *Lorentzii*, Gr. Terebinthaceæ, local name, *Quebracho colorado*. The wood and bark are found in commerce, and valued as an excellent tanning material. This tree grows particularly in the Province of Corrientes.
3. *Jodina rhombifolia*, Hooker et Arnott, Ilicinæ, local name, *Quebracho flojo*. The wood and bark frequently occur in commerce, and are often mistaken for No. 2.
4. *Machærium fertile*, Gr. Leguminosæ Dalbergiæ, synonym, *Tipuana speciosa*, local name *Tipa*. This tree also furnishes wood and bark for tanning purposes, both of which, however, are of less value than No. 2.

It is of little importance to consider the possibility of the latter tree being mistaken for *Quebracho*, as Grisebach, who mentions it as *Machærium Tipa* Benth., in his "Symbolæ," p. 109, has already remarked that Bentham had determined on the authority of Mantegazza, that the naming of this species "*Quebracho colorado*," was evidently an error, the name "*Tipa*," being preferred by the inhabitants of Tucuman for its greater fluency of pronunciation. There remains then no room for doubt that the species of plant to which *Quebracho* bark owes its origin is *Aspidosperma Quebracho* blanco, Schlechtendal, the latter being a positively determined species, and even in its native country is with difficulty confounded with others. The present state of confusion is therefore to be ascribed to the limited knowledge possessed of the new drug.

We will now turn to the consideration of a description of the plant itself. The genus *Aspidosperma* belongs to the Apocynæ. The general peculiarities which distinguish the members of this family are astringent properties, aromatic resins and the property of furnishing a milky juice, at times innocuous, and at others again, very poisonous. The genus *Aspidosperma* was originated by Martius and Zuccarini. In the first volume of the *Nov. gen.*, De Candolle, *Prodromus* VIII, p. 396, ff., there are two sections of these plants described, containing eighteen species. In the essay of Müller von Aargau on the Apocynæ of the Flora *Braziliensis*, we already find described thirty-nine species, likewise divided into two sections. Three species mentioned by De Candolle occur beyond the northwestern limits of Brazil. Further, four extra-Brazilian species are described by Müller von Aargau in Vol. XXX, *Linnæa*, p. 397, as occurring in British Guiana, on the Orinoco, and the Island of Trinidad, and in the forests of Mexico, so that in all forty-six species are known. The species discovered by Burmeister, Schlechtendal was unable to identify with any of those already known, and consequently *Aspidosperma Quebracho* must be added to the above number as an Argentinian species.

Aspidosperma Quebracho is a tall tree with a perfectly straight trunk from two to three feet in thickness, with a moderately large oval crown and sparse foliage, the extreme twigs being very fine and pendent, as in the willow, (something like *Salix Babylonica*). I received from the Göttingen Herbarium specimens of *Aspidosperma Quebracho*, collected by Lorentz and Hieronymus; they consisted of blossoming twigs from plants of first

year's growth and over, and also of the fruits. It seemed to me to be of interest to furnish an exact illustration of a flowering twig, inasmuch as *Aspidosperma Quebracho* has not yet been illustrated. (Plate I, fig. 1). The leaves stand in triple whorls, they are leathery, lanceolate, entire, smooth, veins not prominent, the upper and lower sides both presenting the same appearance. The leaf ends in a sharp pointed thorn. The inflorescence is rather complicated, the flowers are in cymes which have the forms technically termed dichasia or pleiochasia, or sometimes the arrangement resembles the helicoid cyme. The calyx is pentasepalous, the corolla pentapetalous; the petals overlap each other at the base (fig. 1 b); five stamens are attached to the corolla; ovary superior, two celled, with numerous ovules, the pistil carrying a headed stigma, (fig. 1, a. b. c.) The fruit has been accurately described and figured by Schlechtendal,* to whose illustration I refer. It may be noted that its anatomical structure bears a remarkable similarity to that of the bark, inasmuch as the parenchyma of the former is also interspersed with sclerogenous cells.

Grisebach gives the following diagnosis of the species. (*Plantæ Lorentz.* p. 203.):

Aspidosperma Quebracho Schlecht. Simile *A. parvifolio* A. DC. sed foliis oppositis (ternatimque verticillatis) a caractere generico aberrans corollaque aliis speciebus accedens.

Arbor sempervirens, glabra, ligno duro, foliis rigidis glaucescentibus elliptico-lanceolatis subsilibus v. in petiolum brevissimum attenuatis utrinque lævigatis subvenosis margine callosio flavente cinctis apice aristato-mucronatis (1" longis 3—4" latis, cymæ axillares et terminales, trichotomæ, (1" diam), pedicellis patentibus pedunculisque minutissime puberulis, 1—2" longis, calyx 5 partitus ½" longus, segmentis ovatis acutis, corolla lutea, ad medium 5" fida, tubo cylindrico 2" longo, lobis expansis oblongo-linearibus obtusis basi auriculata sinistrorum contortis; antheræ infra faucem sessilis, deltoideo-cuspidatæ; ovaria 2, stylo communi incluso superne clavato minutissime 2 cuspidato; capsula lignosa, margine convexa compressiuscula, ellipsoidea 2½" longa, 1½" lata, 10" crassa, valvis medio carinatis: semina cum ala lata 2" longa, 1" lata.—Cordoba, in campis pr. urbem, inde per provincias Santiago del Estero et Tucuman.

In comparison with the species mentioned and illustrated in the *Flora Braziliensis* (Vol. vi. Part I.) *Aspidosperma Quebracho* assimilates closely to several different varieties. In its inflorescence it approaches most nearly to *Aspidosperma nobile*, *pyrifolium*, *subincanum* and *tomentosum*. In its veneration it resembles *Aspidosperma parvifolium*, differing, however, by the verticillate arrangement and thorny point of the leaves.

EXAMINATION OF THE BARK OF QUEBRACHO.

1. Appearance of the bark when viewed through a lens:

The material which served for this examination was a portion of the first consignment received from Schickedanz. Through the courtesy of Dr. Dingler I was also placed in possession of material in his own hands, and still further a transverse section of the trunk with bark attached was kindly

* Bot. Zeit., 1861., p. 138. Plate V. B.

transmitted by Dr. Penzoldt, who had received it from Prof. Hieronymus in Cordoba. During the course of the examination I received still other samples for comparison from different sources.

The bark occurring in commerce is obtained from trees usually averaging from seventy to eighty years of age. The pieces have a thickness of 20-30 mm. Bark of younger trees, which are devoid of corky layer, is seldom found. Quebracho bark is distinguished by a peculiarly heavy development of the corky layer in proportion to the entire dimensions of the bark, possessing therein an important characteristic feature as compared with other barks. This corky layer makes such inroads into the tissue that in most cases half, and frequently more, of the entire substance of the bark consists of this layer. The external appearance of the corky layer differs from the unchanged tissue beneath it very markedly and distinctly.

A transverse section through an entire piece of bark, made so that a very smooth surface is obtained for examination, reveals the following appearances with or without the aid of a lens. (Plate 1, fig. 2.) Two layers differing remarkably in color and structure, separated from each other by sharply defined boundaries, and which are usually nearly equal in width. (Fig. 2, r. and b.)

The outer layer (b.) is deeply fissured, and rough, with numerous ridges, while the inner one (r.) presents to view a band of tolerably uniform width. The first glance shows that these layers are not of homogeneous composition, and a magnifying glass indicates prominent differences of structure. We will first consider the external or corky layer. The outer portion is of a dirty gray, covered here and there with remains of lichens; when the external grayish portion is removed by friction, it appears yellowish-red, (plate 1, figs. 2 and 4). The transverse section shows the cortical layer to be of an ochreous yellow color. Sinuous bands of tolerably uniform width traverse its tissue in lines of a nearly parallel direction. Between these dirty yellow lines we find numerous whitish points interspersed through the mass. (Plate 1, fig. 2). The inner section of the bark, which represents the fibrous layer, (r. fig. 2.) appears to be composed of only two ingredients, a clove-brown mass in which, as in the bark, there are numerous whitish grains. All these conditions can be more plainly observed on moistening the surface with water. While the corky layer obtained from different trunks presents a uniform appearance, the color of the inner layer may vary considerably. The brown color varies in shade from light to dark, frequently replaced even by light yellow, or yellowish-white. A piece of bark of this description is illustrated in fig. 3. The cause of the difference will appear from a microscopic examination. The inner bark crumbles easily when cut; the portion nearest to the trunk possesses a fibrous splintery texture.

The foregoing descriptions and a comparison of the illustrations will show that the identification of the bark is a comparatively easy matter, inasmuch as it bears no resemblance to other known barks. Of special importance for this identification is the outer corky layer, on account of the constancy of its color and structure.

2. Microscopical examination :

A separate examination of the corky layer and inner bark will also be found most serviceable here. As is well known by the term "corky layer," we understand the structure, which, in consequence of the dying-off and drying-out of successive layers, is separated from the inner bark or cellular layer. When this dead cellular growth remains adhering to the trunk it is finally rent asunder by expansion of the latter, and thus gives to an aged one a rough and fissured appearance. Such layers may be formed successively, and thus increase the depth of the corky portion; in Quebracho this tendency is displayed to a marked extent. A microscopical examination of a thin section of the corky layer shows these relations, (Plate 1, fig. 5): p. is the original cellular tissue composed of parenchymatous elements; it is traversed at varying distances by bands of different width (k.); the cells of these intersecting bands differ remarkably from the original parenchyma of the bark. Owing to their smaller dimensions and their regular order they are characterized as "cork cells;" these cork layers may often be detected with a lens, on a section of the bark, forming the above mentioned parallel lines which intersect the red corky layer. That portion of the bark-parenchyma, lying between these cork bands (p. fig. 5) is that which presents itself to the naked eye as a reddish-yellow ground-work of the structure. This reddish-yellow shade is caused by the coloration of the cellular membrane which contains a coloring matter varying between reddish-brown and carmine-red. It will be noticed at the same time that the membrane of the cork cells is uncolored and, therefore, exhibits a decided difference when examined with a lens. Inasmuch as the cells of the original bark-parenchyma, existing in the corky layer have died, they contain nothing except remnants of former components. It now remains for us to determine the structure of the whitish points observed in the corky layer when viewed microscopically; as they always lie between the cork bands, we should be able to discover them in fig. 5, plate 1. A glance at this enlargement will show cell groups of peculiar structure existing in the parenchyma enclosed between these bands, resembling islands lying in the web itself, (fig. 5, sk.); these grains are nothing else than groups of cells whose membrane has thickened to such an extent from secondary deposits that the cavity has become nearly filled. Owing to the difference in their refracting power with regard to light, these groups of sclerenchymatous cells appear quite prominently and distinctly against the ground work. In the inner bark we also meet with these cells, and under that head they will be considered at greater length. The microscopical inspection of the corky layer presents a very characteristic view; the repeated cork bands and groups of sclerenchyma render the identification of the bark an easy matter. When we examine the inner layer (r., fig. 2) we should be able to discover the same elements which are transformed by secondary processes into the corky layer, with the exception of the cork bands.

This is confirmed by an examination of the section (Plate 2, fig. 6), which represents about a third of the width of the brown fibrous layer, being, in fact,

the inner portion, which was originally in direct contact with the wood. The components of the layer are brown-walled parenchymatous and sclerenchymatous cells lying partly isolated, but again occurring in groups. The parenchymatous cells vary in size; their walls are thickened unevenly and irregularly, and are of a cinnamon-brown color* by which the dark appearance of the layers is caused; the cells are rich in starch and a light-brown granular substance. The entire structure appears to be distorted and disorderly; a close examination, however, will enable us to discover in this confused mass, the medullary rays radiating through it. At many points, especially in the medullary rays, we can discover blackish, thread-like formations consisting of the mycelium of a fungus which has penetrated into the dry bark. The groups of sclerenchymatous cells display the same components as those in the corky layer, their form and appearance being alike in both cases (fig. 6, sk.) differing only from the latter by containing a dark yellow substance occurring in the form of drops, filling up both the cavity and the pore-canals of the cells. It is difficult to determine anything with regard to the chemical nature of this substance; it is insoluble in water, alcohol and ether; treated with potash lye, it dissolves; but it is not possible to remove it entirely from the cells; solution of ferrous salts gives no precipitate, an evidence that it is not an astringent substance. Figure 7 represents a group of sclerenchymatous cells, surrounded by brown-walled parenchyma which shows that the group is not of homogeneous structure, but is composed of two different elements discoverable at the first glance. In this group, there are several cells which are conspicuous by their peculiarity of appearance, readily distinguishable from the preponderating mass. The larger number of these sclerenchymatous cells have a flattened form, resulting from their mutual pressure. These cells are nearly isodiametric, their walls much thickened, and the layers therein easily distinguishable. The cavity has nearly disappeared, and numerous pore-canals reach from it into the thickened wall. These cells are, therefore, so-called "short sclerenchyma," (stone-cells). The second class of cells above referred to, differs in one particular from the remainder, in that they have a nearly circular form. The cavity of these cells has almost entirely disappeared, having contracted to a point in their centre; the thickened wall of these cells is penetrated by very fine pore-canals, frequently indistinguishable. A further inspection shows that these cells occur not only in the groups of sclerenchyma but also appear isolated in large numbers in the parenchyma.

A remarkable feature of these cells is that their periphery is surrounded by a wreath or ring of angular bodies, which refract light in a different manner from the cell-wall. In order to arrive at a thorough knowledge of the structure of these cells they should be viewed longitudinally; there

is no difficulty in preparing a specimen for this purpose; an examination thereof discloses the fact that they are fibres of sclerenchyma which have a considerable length and are spindle-shaped at the ends. (Plate 2, fig. 8). The number of these isolated fibres increases in proportion as we near the inner part of the bark, the splintery structure of this inner portion depending upon the frequency of their occurrence. On scraping the inner portion of the bark with a knife, a microscopic examination shows that we have separated such fibres almost altogether. As these fibres are so characteristic of Quebracho bark, of such value for its identification and of such peculiar anatomical structure, we will consider them at greater length. Naturally, we can obtain from a transverse section of the bark quite a number of sclerenchyma fibres which usually separate spontaneously from the surrounding tissue. Such an isolated section of the fibre always displays the surrounding circle of angular bodies, from which we may conclude that this substance is firmly attached to the fibre. It soon appears that these bodies are crystals and the question arises in what manner they are connected with the fibre itself; this is shown quite plainly by a longitudinal view of the fibre, (fig. 8,) in which we discover that the fibre is completely surrounded by an envelope of this substance, and is actually enclosed in a sheath composed of a multitude of small cells, each containing a crystal. It is sometimes possible to remove this sheath with a knife, which then reveals the spindle-shaped fibre surrounded by its envelope. (Fig. 9). That the crystals are not merely adherent to the exterior of the fibre, but are really enclosed by cell-walls can be demonstrated satisfactorily by coloring one of these fibres with aniline or iodine, and removing the superfluous coloring matter by washing well with water. By this means the cell-wall alone absorbs the dye, the crystals remaining colorless, which can then be clearly distinguished from the former, an illustration of this being found in fig. 10. The crystals are composed of oxalate of lime, for on treatment of the fibre with hydrochloric acid the crystals may be dissolved, leaving the cells empty. If the fibre be now colored with iodine, or aniline, it can at once be discovered that it is surrounded by minute cells. (Fig. 11). That these surrounding cells do not belong to the membrane of the fibre itself, will appear from a consideration of their origin and development given further on. Similar formations, though not always of such complicated structure as the foregoing, exist in the bark of many plants; they have been designated by the name "crystal-sheath;" an especial reference to their occurrence can be found in the article by Sanio in the Monthly Reports of the Royal Academy of Sciences, Berlin, 1857, p. 252, and also in De Bary's Anatomy, pages 104, 502, 544.

3. HISTORY OF GROWTH AND DEVELOPMENT.

Living specimens of the *Aspidosperma Quebracho* were not accessible, to my regret, and for this reason I had to be satisfied with the material obtained from the Herbarium, but could at least obtain therefrom some knowledge of the development of the bark and its elements; to these observations are appended also a few anatomical details of the pith, which is remarkable for the peculiarity of its structural development.

* As has already been remarked some specimens of the inner layer have a much lighter color, (Fig. 3 r), which is owing to the fact that in such pieces the cell wall of the parenchyma is uncolored. While there is no difference in structure between the lighter and darker shades, it seems that the brown coloration of the walls occurs only in aged trees, and is, sometimes, entirely wanting.

The young shoots form wood early, so that one of a year's growth, at the end of the period of its vegetation, already possesses a firm woody ring, though the shoot may be but a millimetre in thickness, even the formation of the periderm having begun, as is shown by the appearance of the first corky layer. That the structural arrangement does not, as a whole, differ from the normal type of dicotyledons is shown by a transverse section of an internode in its earliest development. (Plate 2, fig. 15). Commencing at the centre, we find that from the pith there leads to the wood an irregular tissue of narrow cells, and in the wood may be discovered young wood cells partly with thickened walls, and also young vessels. The bast tissue (figs. 16 and 17) of the vascular bundle is rather limited in quantity, its elements being principally cambiform cells of triangular or multangular section. As is well known, the bast of the *Apocynæ* is noted for its irregularly grouped elements and very narrow, hardly discernible, sieve-tubes. The bark displays in its earliest stages a complex structure.

For the following compare fig. 15. The epidermis, whose cells possess strongly cuticularized outer walls and develop short, hairy formations, is exposed to the risk of dying off by the occurrence of cork cambium in the adjacent cellular tissue of the hypodermic layer. The hypoderma is composed of globular cells with uniformly thickened walls.

Centripetally the cells of the bark become thinner. The inner zone of the bark surrounding the bast is noteworthy; in this zone are found two elements differing from the fundamental tissue; one is the primary sclerenchyma fibre known by its small cavity arising from secondary deposits (sf.) and the second, cells mostly oval on their transverse section and differing by their greater diameter from the remaining bark cells; they surround the bast irregularly in large numbers, or are themselves lying therein.

These cells possess characteristic features both of form and contents; they are entirely filled with an amorphous substance, which in thick layers appears gray, and whose reactions indicate a fatty or waxy substance. It is colored intensely by tincture of alkanet, but potassa produces no effect, while ether dissolves it slowly. These secretory vessels are not of a globular form as might be inferred from the transverse section, (figs. 15 and 17 b.), inasmuch as a longitudinal section shows their form to be that of a duct of considerable length. Two of these superincumbent tubes are separated by a horizontal wall, making it seem as if they had originated from the division of a single cell. It was, however, impossible for me to determine the exact method of their formation, as those found in the youngest samples of material accessible to me had already arrived at maturity.

In older shoots the sclerosis of the bark cells extends over a larger area. In front of the bast of each vascular bundle there appears a group of sclerenchymatous cells, the formation of sclerenchymatous fibres occurring here only at isolated intervals, and it is only in old bark that the formation of sclerenchyma fibres takes place to such an extent that they outnumber the cells of the sclerenchyma. In front of the bast where we now find the scler-

enchyma groups (Fig. 16) there were, originally, the oil ducts; these, through the growth of the bark, have been removed in an outward direction and separated without increasing their number; on the contrary in the older bark, they disappear entirely. Even the primary sclerenchyma fibres which originally lay between the secretory ducts (Fig. 15, sf.) are now exterior to the sclerenchymatous zone bordering on the bast; at the same time, however, the formation of sclerenchyma has begun from the outer portion of the bark; the bark parenchyma lying directly under the first cork layer, being transformed into sclerenchyma, becoming a mantle of several layers of cells.

In the parenchyma which is enclosed by these two zones or layers of sclerenchyma, we find the commencement of the formation of the crystalline envelopes which we have previously found to surround the sclerenchymatous fibres. These envelopes are formed only after the sclerenchyma fibres have attained complete maturity, and are derived from the surrounding parenchyma cells, the process of their formation being rather slow. A transverse section through the young bark shows that in no case is a young fibre surrounded by this ring of cells containing crystals, but that the fibre is enclosed entirely by parenchyma cells. In the bark of older twigs, we often find at first a few, sometimes more of these crystal-bearing cells contiguous to the periphery of the fibre (Plate 2, figs. 13 and 14) from which we can already draw a conclusion as to the gradual formation of this envelope. A longitudinal section of the bark showing the corresponding stages of development gives us a better insight into this formation. (Plate 2, fig. 12.)

The growth of this crystalline envelope begins usually at different points of the exterior of the fibre in a longitudinal direction, each parenchyma cell in immediate contact with the fibre furnishing by its own division the cells which contain the crystals. In most cases these parenchyma cells divide into two daughter-cells by the formation of a wall perpendicular to the longitudinal axis of the fibre. In this mode of division both of the daughter-cells become chambers containing crystals. As figure 14 x shows, the division can also occur by the wall formation taking place parallel to the longitudinal axis of the fibre. In such a case only one of the daughter-cells formed is in immediate contact with the fibre, and only this one becomes a crystal-bearing cell. This mode of division most naturally occurs when the original parenchyma cells present their ends and not their sides to the fibre. It occasionally happens that a longer parenchyma cell may form successively more than two or three crystal-chambers. From fig. 12, we can see that the cells of the fundamental tissue next to the fibre are not drawn into service successively for the formation of these chambers, the series of these crystal-bearing cells being often interrupted by unchanged parenchyma cells which at a later period annex themselves to the others.

In this manner the formation of the sheath proceeds to its completion; at what period of the growth of the bark this stage is reached, I am unable to say, as I was not in possession of specimens intermediate between one to three year old shoots and very old bark. It is very probable

that the division of the cell occurs before the formation of the crystal, for we often find walls in the cells which are becoming part of this sheath and which yet contain no crystals, (Plate 2, fig. 14 x). A circumstance which militates against the view that the crystals appear before the division of the cell, is found in the fact that the crystals never occur in parenchyma cells possessing their original forms and dimensions; that the crystals themselves always fill the divided cells, and are of similar form and size is also an evidence of their secondary formation.

It is naturally difficult to determine whether this large quantity of oxalate of lime has been separated by the fibre itself during its development, and only deposited in the surrounding cells. We may, however, suspect the existence of some such definite relation in their occurrence inasmuch as we already know of analogous cases where deposition of oxalate of lime crystals takes place in the walls of the fibre itself, as in the spicular cells of *Welwitschia mirabilis*, leaving no room for doubt that they are separated by the fibre itself. Another query suggests itself to us in considering this structure, whether the deposition of oxalate of lime is not connected with the process of sclerosis; at any rate, it is worthy of remark that not only surrounding the sclerenchyma fibre itself, but particularly in the young bark in the immediate vicinity of the groups of short sclerenchyma, quantities of oxalate of lime are also deposited in the parenchyma cells, without in this instance taking the form of tubes.

4. FALSE QUEBRACHO BARKS.

In closing the examination of Quebracho bark, it may be well to devote a few words to the false varieties of bark. So far there have appeared in commerce only two false barks, which differ, however, from the genuine Quebracho so decidedly, that it is hardly possible that they will in future be mistaken therefor. One of these barks, a sample of which was obtained from Brueckner & Lampe, Leipzig, and of which considerable quantities were sold, proved to be the *Cortex Copalchi*, long known though little used as a drug. The plant from which it is obtained is the *Croton Pseudochina Schlechtendal*, one of the *Euphorbiaceæ*; its home is Mexico and it has been used as a febrifuge, not only in its native country, but other parts of America; the shipment from which the sample was obtained came from Brazil. *Cortex Copalchi* occurs in commerce in rather long quilled pieces; externally the bark is covered with a dirty white corky layer, more or less fissured, which can be rubbed off in powder. The thickness of the pieces is usually from one to five millimetres according to the age of the twigs from which they are obtained. A transverse section of *Copalchi* bark, examined either with or without a lens, shows a yellowish-white exterior and a dark-brown fibrous layer, which has been formed from the bast of the trunk. The bast fibres are small, converging to a point at their outer end, somewhat bent, and the bark presents in consequence the appearance of flame-like rays of dark-brown color. For the identification of *Copalchi* bark and its distinction from Quebracho, this superficial examination is sufficient, rendering a microscopic examination unne-

cessary; it has in addition an aromatic smell and taste, while Quebracho bark does not possess these properties. A second false variety was obtained from Messrs. Grundherr & Hertel, of Nürnberg; it was a hard bark of uniform dark-brown color, covered with a whitish to grayish-brown corky layer and much furrowed on the interior surface. While I have not yet succeeded in determining the origin of the last variety it is sufficient to state that it bears no resemblance to the Quebracho bark.

ON QUEBRACHO WOOD.

The wood of *Aspidosperma Quebracho* possesses properties similar to those of the bark,* though in a less marked degree, and has been used in its stead, although, in future, the more active bark will undoubtedly be preferred to the wood, which latter, in consequence, will not receive the same pharmacognostic consideration. It, nevertheless, is of considerable interest on account of several anatomical peculiarities.

The Quebracho wood was first shown in 1873 at the Vienna Exposition among a collection of 104 varieties of wood obtained from four provinces of the Argentine Republic, bearing only the local name and without any further descriptive notices.† There was, likewise, a large collection of woods from the La Plata States at the Paris Exposition of 1878; these, however, bore their scientific names and explanatory notices. Among these appeared *Lignum Quebracho Blanco*, with a correct statement of its source, *Aspidosperma Quebracho*.‡

A communication respecting the wood has been given by Dr. J. Möller.* The sample in my possession, was an entire transverse section obtained from Prof. Hieronymus, of Cordoba. The diameter of the woody portion, after the separation of the bark, which latter was about twenty millimetres in thickness, was twenty-nine centimetres, and from the number of rings it must have belonged to a tree about eighty years old, whence we may conclude that the increase in girth takes place slowly.

The wood is not of uniform color, the older wood being of a light chocolate brown, the depth of color decreasing towards the exterior, so that, passing through different shades, the younger wood appears yellowish, or of a light reddish-white. The wood is of exceptionally close texture and hardness and possesses a high specific gravity. With a lens we can discover numerous medullary rays and in the vascular bundles between them, vessels appearing as countless small pores.

A microscopical enlargement of the transverse section (plate 3, fig. 18.) shows this regular arrangement of the three principal constituents and gives us an insight into the structure of Quebracho wood. Between each two medullary rays (m) of varying width, embracing from one to four

* Penzoldt Berliner Klin. Wochenschrift. 1880. No. 10.

† Official report on the Vienna Exposition of 1873 by authority of the Central Committee of the German Empire Vol. II, p. 745.

‡ Report on the Agricultural Section of the Paris Exposition of 1878. Dr. L. Wittmack.—The useful plants of every zone. P. 28, 39, 70, 71.

* Report on the Paris Exposition of 1878. Raw material from the Vegetable Kingdom. Vol. VIII.

rows of cells, we find a woody layer composed of cells with small cavities and thickened membrane. Lying in this woody layer, differing more in size than in form, we find the vessels distributed. The woody layers, which are bounded by the medullary rays, appear at first glance to possess a very uniform composition; a closer inspection, however, even with moderate enlargements, shows that between the wood cells with thickened walls and minute cavity, we find other cells with larger cavities and more delicate membrane; they are shown in the enlargement of the transverse section (fig. 18) as white dots in the woody layer; a greater enlargement of a part of this section enables us to gain a better insight into these relations. In fig. 19, we see two medullary rays, with the enclosed woody layer, in which there is also a vessel. The medullary rays, (m) show nothing abnormal in their form or structure; they consist of prismatic cells arranged horizontally and radially in their longest diameter. A tangential and longitudinal section shows that the edges of the cells are slightly rounded, so that their form approaches that of a cylinder.

The walls of the cells are dotted. The transverse section of the vessels is usually circular or somewhat oval. The wood-fibres (h f.) are very characteristic; a transverse section shows them to be nearly circular, and a bundle of them consequently presents numerous intercellular spaces. The wall is thickened to a marked degree, in which we cannot, however, discover the existence of layers, but very distinct pore-canals are present.

The absence of any layers in their thickened membrane, causes them to refract light in a uniform manner, lending to the wood a peculiar, characteristic, shining appearance. Between the wood fibres and in the immediate neighborhood of the vessels as well as at the boundary of the medullary rays are scattered parenchyma cells. (p.) A complete knowledge of the structure of the wood and the form of its elements is obtained, however, only from a comparison of both longitudinal and transverse sections. The wood-fibres are long and spindle-shaped, of a configuration denominated by Sanio as "libriform," which, however, on the authority of De Bary we simply call wood-fibres. The vessels are jointed at short intervals and their walls are thickly covered with small bordered pits.

A more definite knowledge of the details of its anatomical structure is obtained by maceration with nitric acid and chlorate of potash, by which the elements of the wood are isolated. In figures 20-23 these are shown separately, and it is only by this separation from the mass and each other that it is possible to discover certain peculiarities of form which would otherwise remain concealed. We find that the medullary rays are not composed simply of cells of equal length, but between them we find crystal-bearing cells of smaller size, usually connected in groups of three or four. Each single cell contains a crystal of oxalate of lime and also a mucilaginous substance of homogeneous structure. (Plate 3, fig. 22). It seems probable that a row of such crystal-bearing cells has been produced from a single cell of

the medullary ray. The entire length of such a row of cells is, as a rule, equal to that of a cell of the medullary ray, and the fact of their remaining connected after the maceration, is also in favor of the view that we have only a chambered medullary cell before us.

The wood-fibres have a considerable length, as is shown by figure 20, which represents a part of one with its spindle-shaped extremity. The formation of the pits is remarkable. The pits of wood-fibres in most cases are not bordered. Bordered pits occur, however, in *Quercus*, *Daphne*, *Liriodendron*, *Fraxinus* and according to Sanio's statement, in *Jatropha Manihot*.*

Usually, little can be discovered of the character of the pits in wood-fibres, owing to their minuteness; in the foregoing case, however, they are distinguished by their size and prominence. They are bordered pits forming a relatively wide spherical chamber connecting by a narrow channel with the cavity of the cell; these canals show the usual cleft and crooked appearance. There is nothing remarkable about the vessels inasmuch as they conform to the usual type.

The parenchyma cells constitute the last element to be considered; these, though not showing any peculiarities in their transverse section when isolated, are found to have a very peculiar form, which was discovered by Sanio† and named by him conjugated parenchyma. We find therein finger-shaped protuberances of the membrane, perpendicular to their greatest diameter, usually occurring only on one side, and varying greatly in number, size and form, as shown by plate 3, (fig. 23, a-f). The membrane shows the presence of dots which have the appearance of delicately defined circles, which are, however, not distributed regularly on the walls, sometimes being grouped together in one place, while they are absent from the remaining portion of the wall; again, we find, that they are almost entirely absent.

Sanio's observation with reference to these finger-shaped protuberances, needs a correction in one respect, namely, in regard to the membrane being really continuous, although they appeared to him perforated. In the cells of Quebracho wood the continuity of this membrane is very apparent, as is also the fact of each protuberance being provided with numerous dots; this can be made plainer to the view by coloring sections of the cell membrane as in fig. 23, a-e. A very plain and satisfactory view can be obtained by observing these protuberances from above, as shown by fig. 23, f, which discovers to us the existence of the variable number of these small pits giving the appearance of a sieve to the end of the protuberance; when the protuberances end more pointedly there is usually but a single large pit present (fig. 23, e). The peculiarity of this cell-form has already been observed by J. Moeller, although he failed to notice the existence of pits, in consequence of which in his communication on Quebracho wood,‡ he has given us an erroneous illustration of the cells, which appear as if the pro-

* De Bary's Anatomy, p. 406.

† Sanio. Botan Zeitung, 1873, p. 94.

‡ Dr. J. Moeller, Anatomical Notes, Jarb. f. wiss. Botanik. Vol 12, part 1, plate II, fig. 2.

tuberances possessed a large opening at their ends, which, in itself is highly improbable.

We see from the transverse sections (figs. 18 and 19) further confirmed by delicate longitudinal sections through the wood, that these cells lie isolated between the wood-fibres and surround the vessels in larger numbers; by means of these protuberances, they are connected partly with the vessels and partly with each other. In the lighter-colored, younger wood, they contain numerous large starch grains; in the heart-wood, however, instead of starch, they are filled with a brown substance, as is the case with the medullary rays; the brown color of the heart-wood is owing to the presence of this substance which has already been referred to. This substance is soluble with difficulty in alcohol, more easily in ether and turpentine, if we allow a thin section to stand one or more days in contact with the solvent. In contradistinction to other woods which pass under the name of "Quebracho," we find that the vessels and wood fibres are invariably empty. At both the Universal Expositions the wood of Quebracho Blanco was designated as a tanning material; it is, therefore, somewhat remarkable that we can discover no astringent substance on micro-chemical investigation; neither salts of iron or chromic acid produce the usual characteristic reaction, even when the wood is macerated for a considerable time in contact with the reagents.

Even the bark contains but little astringent matter; from the report of Paschkins* it contains only 3.48 per cent. It must be remembered, however, that tanning materials are of considerable importance for the Argentine Republic and even poor material finds ready application for the reason that large numbers of cattle are annually killed, chiefly for the value of their skins, the preparation of extract of meat having but lately made their flesh of any value. Tanning is, therefore, a very important branch of industry, even though pursued under a great many difficulties caused by the climate, which induces rapid decomposition. The material which is principally used for tanning seems to be, however, the wood and bark of Quebracho Colorado, containing, according to Jean,† fifteen per cent. and according to later authorities even from twenty-one to twenty-three per cent. of astringent matter. This wood has found its way to Europe and also occurs in commerce, here, as a tanning material, either in a chipped condition or else use is made of the extract manufactured therefrom. The similarity of names makes it easy to be mistaken for the wood of *Aspidosperma* Quebracho Blanco. I append therefore a few of the characteristics of the wood of Quebracho Colorado, and also of another wood occurring in commerce under the name of Quebracho. The wood of Quebracho Colorado (*Loxopterygium* Grisebach) is extremely hard and dense. I have in my possession a portion of a twig, with bark attached, of five centimetres in diameter, for which I am

indebted to Dr. Vulpus, of Heidelberg. The bark is much torn and fissured from the large development of the corky layer, externally of a dirty yellow to a dark-brown color and covered with numerous remains of lichens. The surface of a transverse section of the bark is light-brown, discovering many dark parallel corky layers, and at right angles to these, numerous lighter colored lines which are the medullary rays. It is very difficult to mistake this bark for that obtained from Quebracho Blanco. Microscopically, the bark is characterized by the very regular arrangement of its sclerenchyma. The parenchyma of the bark is traversed in a radial direction by numerous medullary rays, between which are arranged with great regularity, rather lengthy, tangentially extended groups of sclerenchyma fibres, which consequently form concentric zones, interrupted by the medullary rays, thus giving to the bark a mapped appearance. These sclerenchyma fibres are also surrounded by a sheath of crystal-bearing cells, possessing a very similar appearance to those in the bark of *Aspidosperma* Quebracho. They are, however, much smaller in diameter and do not lie alone, but exist in groups of a nearly rectangular form. We find, in addition, in the bark-parenchyma a yellowish colored mass of homogeneous appearance, seemingly composed of greatly thickened cell-membranes; they are, however, the compressed membranes of collapsed cells, very probably sieve tubes. The coloration of the wood varies with its age, the heart-wood being dark-brown and the younger wood of a light brown color. It is composed of wood-fibres, wood parenchyma, vessels and medullary rays.

The cells of the wood parenchyma with their dotted walls form a much more considerable portion of the wood than is the case in *Aspidosperma* Quebracho. They are distributed principally around the vessels and contain a large proportion of starch. In the wood-fibre the characteristic pits of *Aspidosperma* are absent, but they are characterized by another peculiarity; the primary membrane is thickened somewhat, the secondary deposit by which the cavity is narrowed has its boundary sharply defined from the remaining membrane, a fact plainly discoverable after treatment with iodine solution. This structural peculiarity distinguishes at once the wood of Quebracho Colorado from that of Quebracho Blanco. The vessels are oval or circular, of different sizes, frequently occurring in groups of two or three, and show only in exceptional cases the formation of hernoid protrusions. They are filled with a mass varying in color from yellow to brown, soluble in water and alcohol and giving a precipitate of a blackish-green color with salts of iron.

Another sample of the wood designated as "Quebracho wood," and obtained from Herr W. A. Bidingen, of Frankfort, differs from both of the above. The origin of this wood could not be satisfactorily determined; it possessed a uniform reddish-yellow color; it is also very hard and dense, but does not possess the coherence of the other two, being of an irregular splintery structure and more easily split. In a chipped condition, it may be confounded with the wood of *Aspidosperma* Quebracho, a transverse section showing even some similarity with the latter. A thorough examina-

* Report of the Paris Exposition, vol. VIII, p. 26.

† Bulletin de la Soc. Chimique, 1878, vol. XXVIII, p. 6. Max Siewert, Tanning materials of South America. Pharmaceutical Journal and Transactions. Third series, vol. VIII, p. 548, 1877-78.

tion, however, permits of positive distinction. The wood fibres do not possess a circular form, but are somewhat angular and consequently lie closer together. The bordered pits of *Aspidosperma* are absent here, as also the parenchyma cells so characteristic of the former. The vessels are thickly filled with hernioid protrusions which contain a substance of a brown color; this substance is also found in the wood fibres and medullary rays. It is easily soluble in alcohol, with difficulty in water, giving in both solvents a blackish-green coloration with iron salts, and is consequently an astringent substance. It is not soluble in ether or turpentine. This substance is frequently found secreted in such quantity, that it exists in large lumps in the space between the elements of the wood, and appears also at other points in the shape of blood-red transparent layers.

THE PITH.

In making a close examination of a transverse section of a two to three year old tree of *Aspidosperma Quebracho*, the observer's attention is especially drawn to the pith which appears in the shape of a regular triangle. This configuration is caused by the peculiar form and arrangement of a portion of the pith mass. Usually the pith of woody dicotyledons is composed principally of parenchyma cells, which increase in number while decreasing in size in proximity to the wood, but still, even near the medullary sheath, are not remarkably different from the cells composing the principal mass of the pith. *Aspidosperma Quebracho*, however, shows peculiar relations of the above region, inasmuch as it is composed of two different elements. The central portion consists of spherical cells, between which are found isolated sclerenchyma fibres. Towards the exterior, both the form and size of these cells change to a narrow-meshed tissue leading to the woody ring. This tissue is already present in a shoot of a years growth (plate 2, fig. 15, m. s). The cells thereof are small, of irregularly triangular, or quadrangular form, possessing a great similarity to those of the bast. In a very young twig the form of a transverse section of the pith is oval, assuming, however, in older twigs, the form of a regular triangle (plate 3, fig. 25). With the increase in girth of the trunk from secondary growth, the bark not keeping pace with the growth of the wood and bast, a considerable pressure is exerted* on the bast portion. This pressure extends even to the pith and causes the alteration of its form. In the specimen under consideration, the following conditions and results may be observed: The wood, owing to the solidity of its cells, is capable of resisting the pressure without alteration of its form. When this pressure extends in an inward direction the central, spherical cells of the pith, exert a certain opposing pressure, as long as they are turgescant. The portion least capable of sustaining the pressure is the tissue composing the outer medullary layer, and consisting of flat cambiform cells, which consequently must yield to the simultaneous internal and external pressure. The result is that a portion of this cellular tissue on being subjected to pressure as

above described, does yield, and especially the innermost part which is adjacent to the spherical pith cells. The pressure is exerted even to the degree of obliterating the cavity of the cells. These masses of cell-walls lying close together present the appearance of a homogeneous mass which in the form of three semilunar plates encloses the pith. The appearance of this triangular section leads us to the conclusion that the pressure on the pith cylinder is not exerted equally; were such the case, the pith should have a circular form. The fact of its taking the shape of a triangle is an evidence that the external pressure is strongest on three sides. The cause of this unequal pressure appears to be immediately dependent on the verticillate arrangement of the leaves. At all events the pressure must be considerably less at the point of insertion of the leaves, than at other parts of the circumference, an opposing force being exerted by the growth of the leaves.

EXPLANATION OF PLATE I.

Fig. 1. Flowering twig of *Aspidosperma Quebracho*, Schlechtendal.

Fig. 1 a. Single flower.

Fig. 1 b. Corolla, opened and spread out.

Fig. 1. c. Ovary.

Fig. 2. *Quebracho* bark, b. cortical layer, r. inner bark.

Fig. 3. Specimen showing inner bark light colored.

Fig. 4. Upper or external part of the bark.

Fig. 5. Transverse section of the cortical layer.

p. parenchyma, k. cork bands, sk. sclerenchymatous cells.

EXPLANATION OF PLATE II.

Fig. 6. Transverse section of inner bark.

Fig. 7. Group of stone-cells in the inner layer.

Fig. 8. Fibre of Sclerenchyma, enclosed in the crystal sheath.

Fig. 9. Longitudinal section of a fibre.

Fig. 10. Transverse section through the fibre and its sheath.

Fig. 11. The same after treatment with hydrochloric acid and removal of the crystals, showing empty cells.

Fig. 12. Longitudinal section through the bark of a twig of *Aspidosperma Quebracho*. Young sclerenchyma-fibre with crystal-sheath in process of formation.

Fig. 13-14. Transverse section through a young sclerenchyma fibre and its neighboring cells, showing the gradual formation of the sheath.

Fig. 15. Transverse section through a one-year-old twig of *Aspidosperma Quebracho*. b. secretory ducts, sf. primary sclerenchyma fibres, m. s., medullary sheath.

EXPLANATION OF PLATE III.

Fig. 16. Transverse section through wood and bark of an older twig of *Aspidosperma Quebracho*.

Fig. 17. Section through bast portion similar to the one represented in fig. 15 with secretory (oil) ducts, b.

Fig. 18. Transverse section of the wood of *Aspidosperma Quebracho*.

Fig. 19. A portion of same more highly magnified.

Fig. 20. Part of an isolated wood-fibre with bordered pits.

Fig. 21. Cell of the medullary ray.

Fig. 22. Chambered cell of the medullary ray containing crystals.

Fig. 23. Isolated parenchyma-cells of the wood with their protuberances.

Fig. 24. Transverse section through a twig of *Aspidosperma Quebracho* about three years old, with triangular pith.

Fig. 25. Transverse section through pith and medullary sheath more highly magnified.

The value below the number of each figure designates the microscopic enlargement.

ERRATA.—The attention of the reader is called to the following errors occurring in the execution of the lithographic plates. In Fig. 18 a number of the wood cells should be represented as white dots, or without the central point; only five or six of them have been so left, hardly noticeable at first view. In the execution of Fig. 23. e. the extremities of the protuberances should also be represented as provided with pore-canals, whereas in the figure they are absent.

* H. de Vries. Flora, 1872, No. 16.



Fig. 5.



sk

Fig 6.
65



Fig 7.
110



Fig 8.
1000



Fig 9.
100



Fig 11.
2000

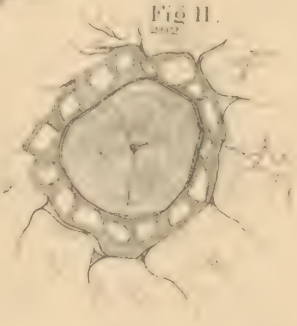


Fig 10.
200

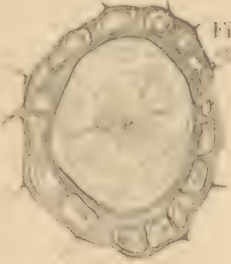


Fig 13.
100



Fig 12.
110

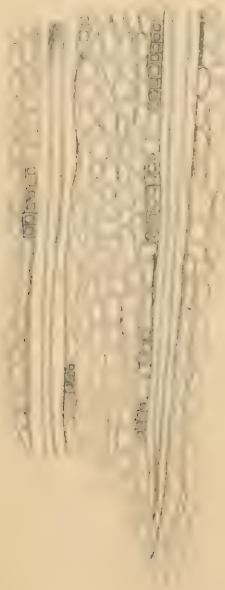


Fig 14.
100

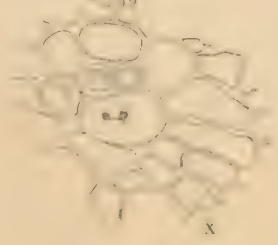


Fig 15.
50





